REMARKS

The Applicants have studied the Office Action dated May 4, 2009. By this amendment, claims 1, 2, 4-6, 8, 12, 14, 18, 19, 21-23, 30, 37, 38, 45, 46 and 48-49 are amended. The following eleven (11) claims are canceled: claims 3, 7, 10, 13, 24-26, 31 and 40-42. The following ten (10) new claims are added: claims 56-65. No new matter was added. After this amendment, claims 1, 2, 4-6, 8, 11, 12, 14, 17-19, 21-23, 27-28, 30, 32, 35, 37, 38 and 43-65 remain pending. Reconsideration and allowance of the pending claims in view of the above amendments and the following remarks are respectfully requested.

In the Office Action, the Examiner:

(1-2) rejected claims 1-8, 10-14, 17-19, 21-28 and 37-55 under 35 U.S.C. §103(a) as being unpatentable over Kristensson ("Design and Evaluation of a Shorthand Aided Soft Keyboard"), hereinafter "Kristensson", in view of Kawamura et al., (US2002/0071607), hereinafter "Kawamura"; and

(3) rejected claims 30-32 and 35 under 35 U.S.C. §103(a) as being unpatentable over Kristensson ("Design and Evaluation of a Shorthand Aided Soft Keyboard") in view of Kawamura et al., (US2002/0071607), and further in view of Milewski et al., ("Medical Word Recognition Using a Computational Lexicon"), hereinafter "Milewski".

(The bolded numbers in parenthesis refers to paragraph numbers of the Office Action.)

<u>(1-3) Rejection under 35 U.S.C. §103(a)</u>

Before discussing in detail the specific rejections, it is believed that a brief review of the art cited by the Examiner would be helpful. Kristensson uses only a crude form of location information, which consists of the location of the bounding box of a gesture as a post-processing step to disambiguate candidates with identical and or nearly identical matching scores according to "normalized shape" information. (See Section 3.5.2, "Partial Location Dependency" of Kristensson, which is a sub-section of 3.5, "Resolving Ambiguity"). The term "normalized shape" means all strokes are transformed to the same origin and the same size; thereby

deliberately removing location information (see Kristensson Figure 4-4). Kristensson does not use probability estimates to do a true mathematical integration. The power of the method of Kristensson is very limited. For example, suppose A and B are two candidates and S is a stroke drawn by a user. If A and B have a same matching distance to S in shape space, but A is closer to S in location, then A can be selected in the post-processing step of Kristensson. However, if A is farther away from S than B is from S in shape space, then A will not be selected as a final top candidate, regardless of the fact that A is much closer to S than B is to S, in location.

On the other hand, in the Applicants' invention, shape and location each produces candidate words with different matching scores that are converted to probabilities that are later mathematically integrated into one ranked list. Using the same example above, if A is somewhat farther away from S than B is, but A is much closer to S than B is in location space, then A may still be selected as the final top candidate, depending the relative weight of the two channels. The Applicants' invention comprises a systematic method of converting matching scores to probability estimates, and then integrates them in a mathematical and probabilistic framework.

Kristensson based his recognition system on the implicit assumption that it would be possible to recognize word shapes based on <u>shape alone</u>. In Kristensson and Zhai (2004, ACM UIST symposium paper) the Applicants computed how many word-shape conflicts there would be if words were recognized based on shape alone. The Applicants found that there were thousands of conflicts. With this background, the Applicants realized the need to also use other sources of information for recognition.

While Kristensson does mention that location information can also be used, Kristensson's method is insufficient for good performance. Kristensson describes a sequential recognition process. First, words are recognized by shape alone. Thereafter, they are separated by location. Kristensson, however, does <u>not</u> describe a complete method for integrating shape and location. It is not clear how Kristensson proposes to take advantage of location information. The closest description is in section 6.1.2.2. which proposes to first do recognition by shape alone, and if there is a conflict (how to make this decision is not explained in Kristensson), then picking the word template whose bounding box distance on the keyboard is the closest to the user's gesture. This latter behavior is a fundamental weakness in Kristensson because it is a hierarchical/sequential decision process, which means that shape information always takes

precedence to location information. However, Kristensson and Zhai (2004) teach that thousands of conflicts arise when looking only at shape. Therefore, a simplistic hierarchical decision process that primarily looks at shape, and then chooses a word template that happens to be closer in location, will result in fragile recognition. What is needed is to take into consideration both shape and location in parallel and integrate both of these "channels similarities" into a combined probability, and thereafter make a decision. How to convert these different measures of shape and location and how to integrate them was an open research question until the Applicants invented the present invention. The leading textbook, *Pattern Classification* (2^{nd} Ed., Wiley) by Duda et al. (2001), for example, does have a chapter on combining several classifiers, but it does not propose the Applicants' method. Further, the fact the Applicants needed to conduct two years of research (one of the inventors ***is*** the author of the Kristensson reference cited by the Examiner), shows that the claimed invention is not obvious.

As noted above, the Examiner rejected claims 1-8, 10-14, 17-19, 21-28 and 37-55 under 35 U.S.C. §103(a) as being unpatentable over Kristensson in view of Kawamura. Independent claims 1, 21, 37, 45 and 49 have been amended to distinguish over the combination of Kristensson and Kawamura. Kristensson only uses a crude form of location information, the location of the bounding box of a gesture (see Section 3.5.2, "Partial Location Dependency" of Kristensson, which is a sub-section of 3.5, "Resolving Ambiguity"), as a post-processing step to disambiguate candidates with identical and or nearly identical matching scores according to normalized shape information. "Normalized shape" means all strokes are transformed to the same origin and the same size hence deliberately removing location information (see Kristensson Figure 4-4). Kristensson does not use probability estimates to do a true mathematical integration. The power of the method of Kristensson is very limited. For example, suppose A and B are two candidates and S is a stroke drawn by a user. If A and B have a same matching distance to S in shape space, but A is closer to S in location, then A can be selected in the post-processing step of Kristensson. However, if A is farther away from S than B is from S in shape space, then A will not be selected as a final top candidate, regardless if A is much closer to S than B is to S in location. On the other hand, in the Applicants' invention, shape and location each produces candidate words with different matching scores that are converted to probabilities that are later mathematically integrated into one ranked list. Using the same example above, if A

is somewhat farther away to S than B is, but A is much closer to S than B is in location space, then A may still be selected as the final top candidate, depending the relative weight of the two channels. The Applicants' invention comprises a systematic method of converting matching scores to probability estimates, and then integrates them in a mathematical and probabilistic framework.

The last four steps of amended claim 1 recite as follows:

> "a shape channel of the plurality of channels measuring a shape aspect of the stroke, and outputting a probability estimate;
>
> a location channel of the plurality of channels measuring location aspect of the stroke, and outputting a probability estimate, wherein the location channel measures the location aspect of the stroke concurrently with the shape channel measuring the shape aspect of the stroke;
>
> mathematically integrating, using Bayes' theorem, the probability estimates of the plurality of channels to produce integrated probability estimates of candidate words corresponding to the stroke; and
>
> based on the integrated probability estimates of the candidate words, recognizing the stroke as a known word."

Support for this amendment is found in the application as originally filed, specifically in paragraphs [0060] to [0068].

Kawamura does not integrate any channels, wherein each channel selectively measures a different aspect of a similarity of the stroke to a plurality of possible paths on the virtual keyboard. Kawamura parses several intra-word strokes using a <u>sequential</u> process that is a very different from the <u>parallel, i.e., concurrent,</u> mathematical integration of all channels performed by the Applicants' invention.

The Examiner cited paragraph [0163] of Kawamura as mathematically integrating the estimates of the plurality of channels to produce integrated probability estimates of candidate words. The cited paragraph [0163] clearly shows that the problem solved by Kawamura is very different problem from the problem solved by the Applicants' invention. Furthermore,

Kawamura uses very different methods (e.g., average vector and covariance vector) from what is claimed by the Applicants. Kawamura does not disclose a plurality of channels of information regarding a same stroke for a word-level keyboard gesture or stroke.

> **[0163]** On the other hand, when the latest stroke is judged not to be the first stroke of the last character of the present I-th candidate character string in the step **1603**, the interval between the stroke and the previous stroke is regarded as the interval between the strokes in the last character of the I-th candidate character string. In this case, in step **1605**, the likelihood is calculated among the structure characteristic vector u2[1 to 2] between the strokes extracted in the step **909** and the average vector v2[1 to 2] and covariance vector φ2[1 to 2] of the structure characteristic between the strokes set in the step **1505**. The logarithm value log f(u2|v2, φ2) is accumulated and set to the logarithm likelihood of the corresponding character structure portion of the I-th candidate character string, that is, the character structure portion of the last character of the present I-th candidate character string. Thereafter, the flow advances to the step **1606**. The probability density function having a form similar to that of the step **1604** is used in the calculation of likelihood.

The Examiner argued "…It would have been obvious to one of ordinary skill in the art at the time of the invention to automatically recognize characters as suggested by Kawamura (paragraph [0013])." The Applicants respectfully disagree. Kawamura is about recognizing characters "when the user simply successively writes characters without being conscious of an end of the character". With Kawamura, a user inputs <u>character-level</u> strokes. With the Applicants' invention, a user does not input character-level strokes, and the system in accordance with the Applicants' invention does not bother to recognize characters. With the Applicants' invention, a user inputs <u>word-level</u> strokes on a keyboard, and the system in accordance with the Applicants' invention recognizes an entire word. It is not obvious, even with the benefit of hindsight, to use Kawamura to solve the problem solved by the Applicants' invention because the individual characters in a string in Kawamura do not correspond to a plurality of channels of information processing different aspects of a same stroke in order to recognize an entire word.

The combination cited by the Examiner does not disclose the step of mathematically integrating, using Bayes' theorem, the probability estimates of the plurality of channels to produce integrated probability estimates of candidate words corresponding to the stroke, as recited in the next-to-last step of amended claim 1. Bayes' theorem is described in [0068] and equation (9), to wit:

> "The shape channel 210 and location channel 215 may each have multiple candidate words. Integrator 230 then integrates the candidate words from the shape channel 210 and location channel 215 into a final N-best list, with a probability for each candidate word as:
>
> $$p(i)=\frac{p_s(i)\,p_l(i)}{\sum_{j\in W_s\cap W_l} p_s(j)\,p_l(j)} \qquad (9)\text{"}$$

where p_S is the probability estimate from the shape channel, p_L is the probability estimate from the location channel, W_S is a set of candidate words outputted from the shape channel, and W_L is a set of candidate words outputted from the shape channel. The last four steps of amended claim 1 are not taught or disclosed by the combination of Kristensson and Kawamura. In particular, the combination of Kristensson and Kawamura does not teach parallel processing of different measures of a stroke's similarity to a known word. Additionally, the combination of Kristensson and Kawamura does teach using Bayes' theorem to mathematically integrate the probability estimates of the plurality of channels, to produce integrated probability estimates of candidate words corresponding to the stroke.

Specifically regarding the rejection of dependent claims 3 and 8, claim 3 was canceled, but at least some of the recitations that formerly appeared in claim 3, now appear in amended claim 8. In rejecting claim 3, the Examiner cited:

"... regarding sample point of the stroke, each sampling point having a weight (Section 4.3.1, "Non-destructive interpolation")"

The Applicants' respectfully submit that the Examiner is mischaracterizing Kristennsson. Section 4.3.1 of Kristensson describes how to interpolate between sampling points of a stroke. Nowhere in the Section 4.3.1 is the topic of assigning weights to the sampling points for computing impact of the different points of a stroke discussed. Also, amended claim 8 recites a location channel. There is no location channel in Kristensson.

Kristensson (section 6.1.2 "partial location dependence") uses only a crude form of location information. Kristensson discloses location information of a stroke using a "bounding box", in which extreme points of a stroke may be determined and used, but Kristensson fails to disclose location information of a stroke using sampling points of the stroke that are interior of the extreme points of the stroke, as recited in amended claim 8. Furthermore, the Applicants' invention uses different weights for the sampling points from beginning to end of the stroke. Kristensson fails to disclose each sampling point having a different weight, wherein a sampling point at the beginning of the stroke has a greatest weight and a sampling point at the end of the stroke has a least weight, as recited in amended claim 8. Kristensson does not weigh each corresponding sample point according to a weighing function. Instead, Kristensson calculates the minimal distortion (or stretching) required to transform one shape into another shape. Equations 4.10 and 4.11 of Kristensson do <u>not</u> constitute a weighing function for adjusting the relative importance of the stroke sample points from beginning to end.

The Examiner stated that claim 8 is anticipated, in part, by Chapter 4.2.2.1, "Elastic Matching of two Curves" of Kristensson. For convenience, Figure 4-7 of Kristensson is reproduced below in its entirety.

```
function MIN-DISTANCE(unknown, prototype) returns min-distance

  n←LENGTH(unknown)
  m←LENGTH(prototype)
  Create a distance matrix distance[n+1,m+1]
  distance[0,0]←0
  for each column i from 0 to n do
    for each row j from 0 to m do
      distance[i,j]←COST[unknown_i,prototype_j] + MIN(distance[i-1,j],
                                                      distance[i-1,j-1],
                                                      distance[i,j-1])
  return(distance[n,m])
```

Figure 4-7 Dynamic time warping algorithm.

Chapter 4.2.2.1, of which Figure 4-7 is a part, is entitled "Elastic Matching of two Curves", and this chapter describes how a curve u that has an unknown shape can be matched to a known candidate curve k. Figure 4-7 merely sets forth an algorithm for determining shape information. Therefore, chapter 4.2.2.1 and Figure 4-7 refers to shape information but <u>only</u> to shape information (and to no other type of information). Therefore, chapter 4.2.2.1 and Figure 4-7 refers, at most, to only <u>one</u> channel of a possible <u>plurality</u> of channels, wherein that one channel is a shape information channel. In other words, chapter 4.2.2.1 and Figure 4-7 do not describe a situation of more than one channel, (e.g., a <u>plurality</u> of channels), as recited claim 1, upon which claim 8 is dependent. For example, chapter 4.2.2.1 and Figure 4-7 do not refer to other channels of a plurality of channels, such as a location information channel or a shape channel, as recited in claim 1. Therefore, claim 8 should be allowed for at least the foregoing reason.

Specifically regarding the rejection of dependent claims 4 and 10, claim 10 was canceled, but at least some of the recitations that formerly appeared in claim 10, now appear in amended claim 4. The Examiner cited Figure B-2 of Kristensson as disclosing "wherein the plurality of channels comprising a tunnel model channel". This is inaccurate. Figure B-2 of Kristensson illustrates the trace for the word "the" inside the keys **O**, **T**, **H**, **E** and **N**. This is only coincidental (note that the text-label for Figure B-2 simply states "Notepad GUI", and does not state, or even suggest, "tunnel". There is nothing in Kristensson that articulates anything to the

effect of the tunnel constraint. Figure B-2 of Kristensson merely illustrates the user's attempt to write the word "the" so the recognition method that is solely based on shape could recognize it. If the Examiner looks at the example in Figure B-2 of Kristensson carefully, the Examiner will see the stroke is **O-T-H-E-N**, so the overall shape is very similar to **t-h-e**. It was merely coincidental that the stroke crossed **t-h-e**. Nowhere in Appendix B or Figure B-2 is the word "tunnel" mentioned. Furthermore, nowhere in Appendix B or Figure B-2 is the tunnel channel concept discussed using any other terminology. Except for a single appearance of the word in chapter 3.3 when discussing the prior art, Kristensson does not discuss the tunnel channel concept. Furthermore, the concept of "channel", as it is disclosed in the Applicants' invention, is simply not in Kristensson. Additionally, amended claim 4 has been narrowed to include the limitation, "wherein the tunnel of a word pattern comprises a predetermined width on either side of a set of the virtual keys representing a set of letters of a word on the virtual keyboard, and wherein the tunnel model channel is applied to the stroke before any other channel is applied to the stroke", which is also not taught by Kristensson.

Specifically regarding the rejection of dependent claim 5, the Examiner stated in rejecting claim 5 that "*wherein the plurality of channels comprises a language context channel*" is disclosed by Appendix D of Kristensson. There is no disclosure of a language context channel in Kritensson. Appendix D of Kristensson is merely a list of words, as the title to Appendix D, "Words Used in the User Study", strongly suggests. There is no relationship between a list of words used in a study, on the one hand, and the language context channel of the Applicants' invention, on the other hand. There is nothing in Kristensson that argues for using a language model as the term "language model" is defined in the Applicants' patent application. Further, Appendix D of Kristensson is simply a list of words and their shapes, and does not suggest, teach or disclose how to integrate language modeling information into a recognizer's metric. Additionally, claim 5 has been narrowed to include the limitation, "a language context channel that stores recognized known words, and wherein the language context channel provides clues for recognizing a word based on a stored previously recognized known word", which limitation is not taught by Kristensson.

If the Examiner were to look at Appendix D again, the Applicants are confident that the Examiner will notice that Appendix D does not disclose a *"language context channel"*, as recited in claim 5. There is nothing in Kristensson that argues for using a language model, as the term "language model" is defined in the Applicants' patent application. For example, the Applicants' patent application states,

> "The present system uses **language rules** to recognize suffixes and connect suffixes with a preceding word, allowing users to break complex words into easily remembered segments." (Emphasis added) See paragraph [0018] of the Applicants' Published Patent Application 2005/0190973 A1.
>
> "Several other factors can also contribute the overall likelihood of a word, such as the **language context** (proceeding words), etc." (Emphasis added) See paragraph [0025] of the Applicants' Published Patent Application 2005/0190973 A1.
>
> "The **language model channel** 235 provides context clues to the integrator 230 based on previous words gestured by the user." (Emphasis added) See paragraph [0046] of the Applicants' Published Patent Application 2005/0190973 A1.
>
> "When a suffix is detected by integrator 230, integrator 230 obtains the previous word from the **language model channel** 235. If the previous word and the suffix match, they are connected according to rules in the lexicon 225. The rules can be any set of instructions feasible for connecting a word stem and a suffix. For example, the rule for connecting "compute" and "tion" is to delete the previous character (e.g., "e"), insert "a", and insert the suffix." (Emphasis added) See paragraph [0096] of the Applicants' Published Patent Application 2005/0190973 A1.

Finally, Appendix D of Kristensson is simply a list of words and their shapes, and does not suggest, teach or disclose how to integrate language modeling information into a recognizer's metric. Therefore, claim 5 should be allowed.

With specific regard to the rejection of claim 14, first, there is no reference in Kristensson to "morphing" or "animation" feedback wherein a user's gesture is gradually (over time) transformed into the ideal gesture. Secondly, Kristensson calculates a scalar value: the minimum spatial distance between two shapes. On the other hand, claim 14 refers to generating an intermediate shape. The Applicants' patent application describes using linear interpolation; while in Kristensson, all shape comparisons are calculated using elastic matching. Kristensson does not disclose a user feedback mechanism. The Applicants' invention generates and displays

intermediate shapes to the user. The Applicants' patent application explains that this method is useful because it enables a user to see how "sloppy" the user gestured a particular word. On the other hand, Kristensson merely discloses calculating how "close" shapes are to each other (see Chapter 4.2.2.1 in Kristensson). Additionally, claim 14 has been amended.

With specific regard to the rejection of claim 17, Chapter 3.7.3 of Kristensson refers to two different modes of entry: the user can either tap or the user can trace a word. On the other hand, claim 17 refers to information required to initiate the matching process.

With specific regard to the rejection of claim 18, Kristensson does not sample the word pattern and the stroke into a same number of points. Rather, Kristensson calculates a minimum stretching distance between two point sets. The Applicants' invention does not stretch any pattern in the comparison metric. This is possible because the Applicants' invention samples both the word pattern and the stroke into an equal number of points. Additionally, claim 18 has been amended to include the limitation, "sampling the stroke to a same fixed number of a plurality of points", which is not taught by Kristensson.

With specific regard to the rejection of independent claim 21, the Applicants respectfully disagree with the Examiner that claim 21 is analogous to claim 1. The third and fourth elements of claim 21 were extensively narrowed to further distinguish it over the combination of Kristensson and Kawamura. The combination cited by the Examiner fails to disclose, a combination of a plurality of channels, each channel selectively processing, <u>in parallel</u>, a different aspect of a stroke, as recited in the third element of amended claim 21.

Independent claim 37 has also been amended to further distinguish it over the combination of Kristensson and Kawamura. The second step of independent claim 37 was amended as follows:

> "accepting a stroke **that represents one whole word** as an input on the virtual keyboard;"

The second step of amended claim 37 is not taught or disclosed by the combination of Kristensson and Kawamura. The "strokes" of Kawamura are intra-word units, or characters. For example, a stroke of Kawamura corresponds to a character such as one letter of a multi-letter word. A single stroke of Kawamura does not correspond to an entire multi-letter word. Typically, Kawamura would require several strokes to form a single word. Kawamura's integration concerns a process that combines <u>several</u> individual strokes into the characters of a word. On the other hand, a stroke, as defined in the Applicants' invention, corresponds to an entire word and always corresponds to exactly one word only.

Claims 2, 4, 5, 6, 8, 11, 12, 14, 17, 18 and 19 depend from independent claim 1, claims 22, 23, 27, 28, 30, 32 and 35 depend from independent claim 21, and claims 38, 43 and 44 depend from independent claim 37. Because dependent claims contain all the limitations of the independent claims, it is believed, for at least this reason, that claims 2, 4, 5, 6, 8, 11, 12, 14, 17, 18, 19, 22, 23, 27, 28, 30, 32, 35 38, 43 and 44 distinguish over the combination of Kristensson and Kawamura, as well.

Regarding specifically the rejection of independent claim 45, the second step of claim 45 was amended as follows,

> "accepting a stroke as an input on the virtual keyboard**, wherein the stroke represents exactly one word**;"

The second step of amended claim 45 is not taught or disclosed by the combination of Kristensson and Kawamura. A stroke of Kawamura is an intra-word unit, such as a character. For example, a stroke of Kawamura may correspond to one letter of a multi-letter word. Typically, a stroke of Kawamura does not correspond to an entire word. Kawamura's integration concerns a process that combines <u>several</u> individual strokes into the characters of a word. On the other hand, with the Applicants' invention, a single stroke corresponds to an entire word, and always corresponds to exactly one word only.

Claims 46-48 depend from independent claim 45, and because dependent claims contain all the limitations of the independent claims, it is believed, for at least this reason, that claims 46-48 distinguish over the combination of Kristensson and Kawamura, as well.

As noted above, the Examiner rejected claims 30-32 and 35 under 35 U.S.C. §103(a) as being unpatentable over Kristensson in view of Kawamura and further in view of Milewski. Claim 31 was canceled. Independent claim 21, upon which claims 30, 32 and 35 depend, has been amended to distinguish over Kristensson. The combination cited by the Examiner fails to disclose, a combination of a plurality of channels, each channel selectively processing, in parallel, a different aspect of a stroke, as recited in the third element of amended claim 21. Therefore, amended independent claim 21 distinguishes over Kristensson in view of Kawamura and further in view of Milewski. Claims 30, 32 and 35 depend from claim 21. Because dependent claims contain all the limitations of the independent claims, 30, 32 and 35 distinguish over Kristensson, Kawamura and Milewski, as well, and the Examiner's rejection should be withdrawn.

For the reasons set forth above, the Applicants believe that the rejection of claims 1-8, 10-14, 17-19, 21-28 and 37-55 under 35 U.S.C. §102(b) has been overcome.

Conclusion

In view of the preceding discussion, it is submitted that the claims are in condition for allowance. Allowance of claims 1, 2, 4-6, 8, 11, 12, 14, 17-19, 21-23, 27-28, 30, 32, 35, 37, 38 and 43-65 is requested.

No amendment made was related to the statutory requirements of patentability unless expressly stated herein. No amendment made was for the purpose of narrowing the scope of any claim, unless the Applicants have argued herein that such amendment was made to distinguish over a particular reference or combination of references.

The Applicants acknowledge the continuing duty of candor and good faith to disclose information known to be material to the examination of this application. In accordance with 37 CFR §1.56, all such information is dutifully made of record. The foreseeable equivalents of any

territory surrendered by amendment are limited to the territory taught by the information of record. No other territory afforded by the doctrine of equivalents is knowingly surrendered and everything else is unforeseeable at the time of this amendment by the Applicants and their attorneys.

The present application, after entry of this response, comprises forty-five (45) claims, including five (5) independent claim. The Applicants have previously paid for forty-six (46) claims including five (5) independent claims. The Commissioner is hereby authorized to change any fees that may be required or credit any overpayment to Deposit Account **09-0441**.

PLEASE CALL the undersigned if the Examiner believes that there are any informalities that can be corrected by Examiner's amendment, or that in any way it would help expedite the prosecution of the patent application.

Respectfully submitted.

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